Item #5d

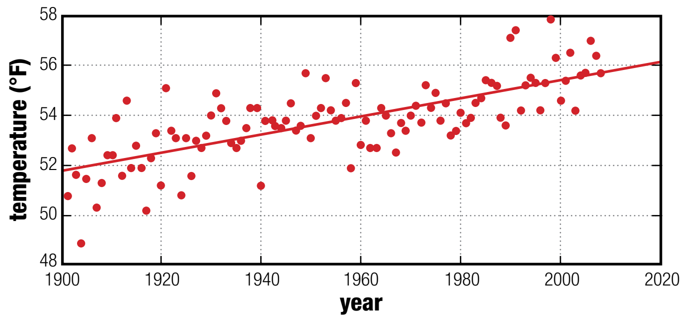
National Aeronautics and Space Administration

ADAPTING TO A CHANGING CLIMATE

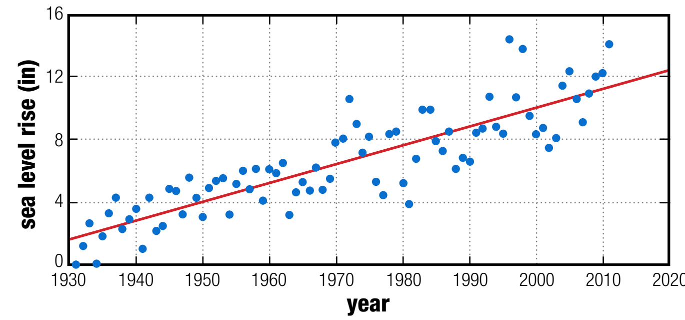
Federal Agencies in the Washington, DC Metro Area

What we're seeing now

Weather and climate are changing. Over 100 years of data collected from the area tell the story: the average annual temperature has risen about 4F, as measured in Beltsville, MD. Sea level, measured in the District of Columbia, has risen almost 10 inches over the past 80 years.



Observed Temperature



Observed Sea Level

Scientists project that these trends will continue, and even accelerate, this century. Furthermore, this warming is driving changes in the frequency and intensity of extreme weather events. Changes in extreme events may include more downpours, more drought, and more heat waves. At facilities vulnerable to coastal storms, rising sea levels magnify the effect of intense storms, producing serious potential impacts from storm surge and flooding.

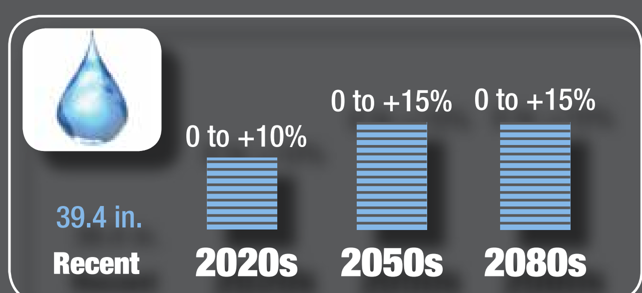
Washington, DC has experienced several extreme weather events in recent years. Three days of intense tropical downpours in June 2006 swamped the downtown. A cluster of tornadoes in April 2011 put the city on edge. Hurricane Lee in September 2011 produced 7 inches of rain in 3 hours in some parts of the region. A string of days over 100 degrees in July 2012 kinked the tracks of a Metro route, leaving many commuters stranded. And DC residents learned a new word this year – derecho – a widespread and long-lived wind storm that accompanies rapidly moving showers and thunderstorms. The June 29th derecho caused massive tree damage and flooding to the area; power outages across the District disrupted life for several days.

What scientists project

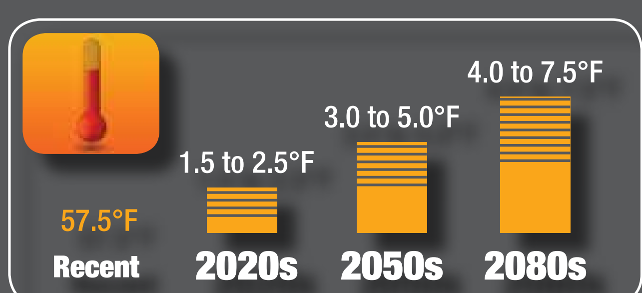
Climate scientists from NASA's Goddard Institute of Space Studies used site-specific climate data from the DC area, combined with climate model outputs, to generate temperature and sea level rise projections for the area. The projections indicate continued rising temperatures and sea levels in the area. Sea levels may rise considerably faster if land-based ice melts faster than most current models project. (See the Rapid Ice Melt projections below.)

Average temperatures and sea levels are projected to rise, but most people are more likely to notice the increase in some kinds of extreme events. Changes in the number of hot days and cold days may affect energy usage patterns, health (e.g., asthma), plant and animal habitats, and infrastructure function (e.g., buckling of concrete roads).

What might the Metro DC area's future look like?

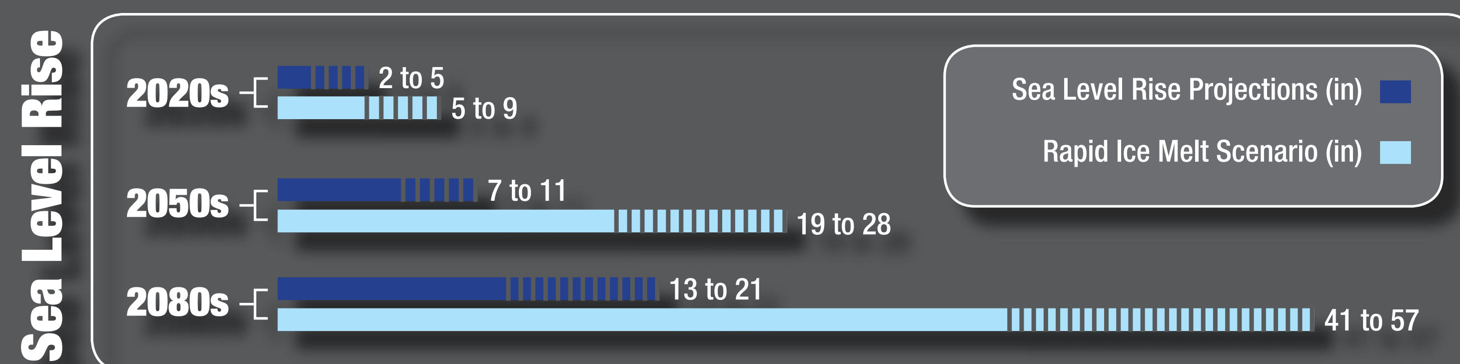


Change in Average Annual Precipitation



Change in Average Annual Temperature

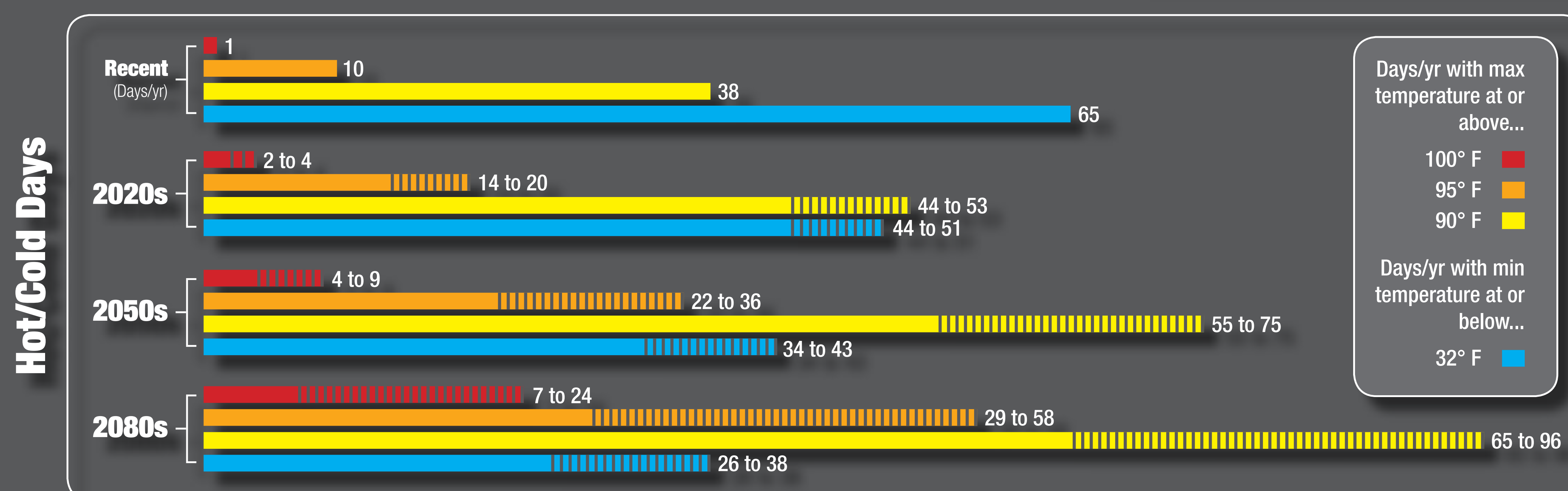
Temperature and precipitation projections reflect a 30-year average centered on the specific decade; sea levels are averages for the specific decade. Temperatures are rounded to the nearest half degree, precipitation projections to the nearest 5%, and sea level rise to the nearest inch. Shown are the central range (middle 67% of values) across the Global Climate Models and greenhouse gas emissions scenarios.



Extreme Event Changes This Century

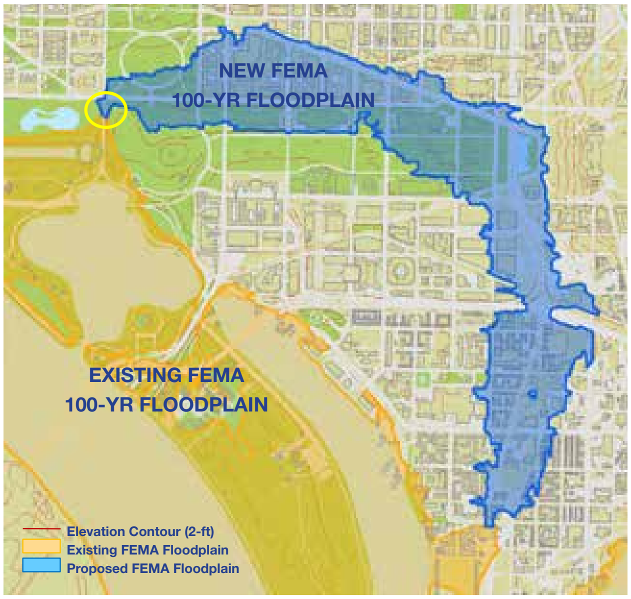
Event	Direction of Change	Likelihood
Heat Stress	↑	Very Likely
Snowfall Frequency and Amount	↓	Likely
Intense Precipitation Events	↑	Likely
Drought	↑	More Likely than not
Ice Storms/freezing rain	↑	About as Likely as not

Based on global climate model simulations, published literature, and expert judgment. Source: NASA GISS. Likelihood definitions (>90% Very likely, >66% Likely, >50% More likely than not, 33 to 66% About as likely as not) based on IPCC.



A practical response

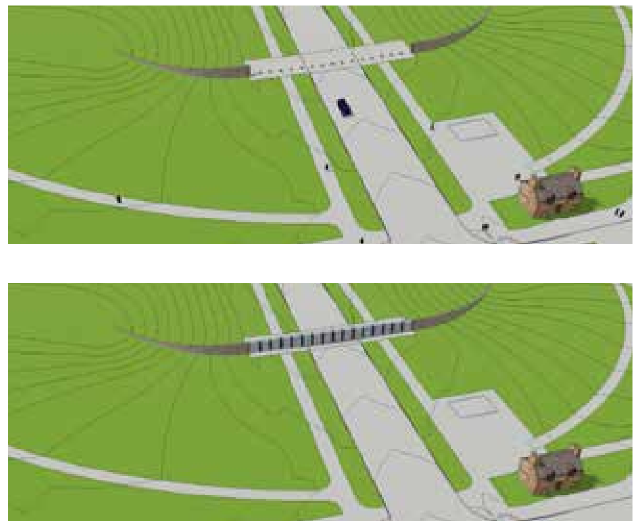
A practical response is to consider horizontal and vertical infrastructure (the built environment), natural resources, and workforce assets and capabilities that federal agencies manage, determine potential climate impacts, identify possible adaptation strategies, and adjust management plans as necessary. The timeline for adaptation strategies can be linked to the timelines for projected trends. Flexible adaptation pathways can allow for consideration of updated information as time progresses.



17th Street Levee in the Monumental Core

Adaptation underway in DC

The National Capital Planning Commission is planning updates to flood control and stormwater conveyance systems. Improvements to the Anacostia levee were made after Katrina in 2005. A new 8-foot post-and-panel structure that will enable temporary closures is being built across 17th Street, NW, near Constitution Avenue. In 2011, several federal agencies and DC departments collaborated on a Federal Triangle Stormwater Drainage Study that assessed several stormwater solutions. Other federal agencies are also looking at the need for adaptation measures for their properties in DC and elsewhere in the nation.



17th Street Levee improvements

*Images are from March 3, 2011 presentation *Washington, DC Flooding Protection*, by National Capital Planning Commission

A Note about Downscaling Climate Data for Specific Areas

The quantitative climate projections in this document are based on global climate model simulations conducted for the IPCC Fourth Assessment Report (2007) from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project Phase 3 (CMIP3) multi-model dataset. The simulations provide results from sixteen global climate models that were run using three emissions scenarios of future greenhouse gas concentrations. The outputs are statistically downscaled to 1/8 degree resolution (~12 km by 12 km) based on outputs from the bias-corrected (to accurately reflect observed climate data) and spatially-disaggregated climate projections derived from CMIP3 data. Results provide a more refined projection for a smaller geographic area. This information is maintained at: **http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections** and described by Maurer, et al. (2007)[1].

The rapid ice melt scenario and qualitative projections reflect a blend of climate model output, historical information, and expert knowledge. For more information about rapid ice melt, see a paper and references at: **http://www.nature.com/climate/2010/1004/pdf/climate.2010.29.pdf.**

Key Uncertainties Associated with Climate Projections

Climate projections and impacts, like other types of research about future conditions, are characterized by uncertainty. Climate projection uncertainties include but are not limited to:

1) Levels of future greenhouse gas concentrations and other radiatively important gases and aerosols,

2) Sensitivity of the climate system to greenhouse gas concentrations and other radiatively important gases and aerosols,

3) Climate variability, and

4) Changes in local physical processes (such as afternoon sea breezes) that are not captured by global climate models.

Even though precise quantitative climate projections at the local scale are characterized by uncertainties, the information provided here can guide resource stewards as they seek to identify and manage the risks and opportunities associated with climate variability/climate change and the assets in their care.

[1]*Maurer, E.P., L. Brekke, T. Pruitt, and P.B. Duffy (2007), 'Fine-resolution climate projections enhance regional climate change impact studies', Eos Trans. AGU, 88(47), 504.*